

## Title

Development, Capabilities and Policy

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## Abstract

This paper discusses the role of capabilities - and policies that affect these - for growth and development. The capability concept is a much used in analyses of firms. However, it also used at the level of nations. Capabilities at the national level may be defined broadly as "social capabilities", as done by the economic historian Moses Abramovitz, or more narrowly as "technological capabilities" as suggested by for instance the development scholars Lin-Su Kim and Sanjaya Lall. This paper argues that technological and social capabilities interact in the process of development, and that policy may have a great impact not only through traditional science and technology policies, but also through its impact on the broader social capabilities which, the paper argues, are crucial for the exploitation of technological capabilities. Based on recent research the paper discusses how technological and social capabilities can be measured and how growth and development are affected. Factor analysis on a broad set of indicators covering various aspects of these capabilities is used to generate empirical measures (composite variables) of technological and social capabilities. This leads to the formulation of an econometric model which is applied to a pooled cross-country time-series dataset of covering 100 countries between 1995 and 2011. Various other factors identified in the literature on growth and development as being potentially relevant are also included (sensitivity test). The final section presents the conclusions from the study and discusses the implications for policy in countries with different characteristics/development levels.

Keywords: competitiveness, capabilities, development, innovation.

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## Keywords

Development, Policy, Social Capability, Technological Capability, Governance, Factor Analysis.

“The present state of the nations is the result of the accumulation of all discoveries, inventions, improvements, perfections and exertions of all generations which have lived before us: (...) every separate nation is productive only in the proportion in which it has known how to appropriate those attainments of former generations and to increase them by its own acquirements”

Friedrich List (1841, p. 113).<sup>1</sup>

## 1. Preliminaries

One of the most challenging questions in economics is this: Why do some countries perform so much better economically than others over long period of times? This is of course a matter of great theoretical and practical importance, and for this reason it has attracted interest from economists for centuries. In fact, already Adam Smith struggled with this question. And, as the above quotation from List (1841) - in a rebuttal to Smith’s reasoning about the subject - shows, the idea that this has something to do with a country’s capability to absorb, exploit and create knowledge has been around for a long time. Still the issue continues to be surrounded by controversy.

One of the reasons for this state of affairs has to do with resistance by many economists to the use of concepts such as knowledge, capabilities and competitiveness in connection with analyses of how countries or regions perform. Such factors, it is argued, are attributes of individuals, not collectives. Hence, what economists should do, following this view, is to analyse economic development as the result of interaction between individuals that seek to maximize their own welfare. However, whatever the merits of this approach, what seems clear is that it substantially reduces the range of phenomena that the analyst can meaningfully say something about (and hence influence). Arguably, many if not most issues that managers or policymakers are concerned about simply slip under the radar of analysts basing themselves solely on this individualist approach. Their need for advice is instead met by a more practically oriented literature, often related to the consultancy industry, based on the exploration of popular concepts, frameworks and exemplars considered to be relevant for decision-making in organisations at various levels. At the national level a typical example is the construction by consultancy companies (and others) of composite indicators of competitiveness ranking countries according to how competitive (successful) they are (IMD 2012, WEF2011). By taking into account the various dimensions that go into such indicators and how they are weighted together it is then possible to derive conclusions about the sources of a country’s success – or lack of such – relative to others and hence what might be done about it. Although the construction of these indicators is often almost void of theory (and based on very simple empirical methods), the interpretation of reality they convey and the advice this leads to receive much attention both in the media and among policy-makers.

Economists should be able to do better when it comes to providing relevant policy advice. While the individualist approach may be useful for analyzing certain issues, it should also be recognized that a collective cannot always be reduced to the sum of the attributes of the individuals joining it. Collectives such as firms, organisations and nations are more than the

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<sup>1</sup> Cited after Soete et al (2010), p. 1161

mere sum of the individual parts. They are repositories of knowledge, institutions and resources that significantly influence the actions – including interactions – of their members in their efforts to create and exploit economic value. By joining a member typically has to accept a whole “package” of such characteristics (although they may eventually be modified through collective action). Time and history also matter here. For example the “package” that individual members are faced with may be strongly influenced by processes that took place in the past and conditions that helped to shape them. Even if these conditions change, the ways of doing things they gave rise to may be surprisingly persistent. Hence, changing such collective characteristics is often a slow and difficult process.

It is also sometimes argued that use of concepts such as capabilities and competitiveness at the country level implies wrongly applying firm-level theories to the analysis of entire nations. This is wrong, the argument goes, because firms and nations are altogether different entities, and, hence, require different theoretical approaches to be adequately understood. However, while it is certainly true that there are differences between firms and nations that should not be overlooked, there are also similarities that ought to be taken into account. Both firms and countries are organized entities in which populations, based on their skills and resources, interact to create value, which is then distributed across the population according to certain criteria. Moreover, they both have systems of governance which significantly influence the creation and distribution of economic value and that affect their performance. A fundamental difference, it is often argued, is that firms can go bankrupt (and eventually be forced out of business) while nations cannot. But history is replete with examples of nations that did not survive, often because they were less efficient than others economically. The Soviet Union comes to mind as a relatively recent example. Moreover, Eastern Germany was merged with (taken over by) Western Germany, not only for political and cultural reasons, but to a large extent because the economic conditions that it offered its citizens were not competitive with those of its more efficient Western counterpart. Today the governments of Greece, Portugal, Spain and others are exposed to a lot of pressure from financial markets, international organizations and other governments for failing to keep their current accounts balanced. Hence, although there are important differences between countries and firms, the economic environment in which these entities operate, with its capitalist, knowledge-based dynamics, is essentially the same, and so are many of the factors that influence their performance. Using related concepts and understandings to analyze these challenges should therefore not be regarded as a deadly sin but on the contrary as quite natural. Doing so may also have the added (arguably non-trivial) benefit that it provides policy makers and managers with a common language for dealing with some of the challenges and opportunities they are facing.

The structure of the paper is as following. Section 2 discusses the part played by knowledge in economic growth, and the role of technological and social capabilities for the successful exploitation of knowledge towards this aim. How such capabilities can be measured is the topic under consideration in Section 3. Section 4 presents a simple model linking capabilities with growth and competitiveness. The subsequent section contains results from estimating the model on real world data from the two last decades. Finally, section 5 presents conclusions and points to topics for future research.

## 2. Knowledge, Economic Development and Capabilities

Most people today would easily accept the view that knowledge and development are two sides of the same coin. But this is not the way growth and development normally has been analysed in economics. Rather, from the classical political economists onwards, growth and development has been seen as arising from accumulation of capital. One possible explanation for this may be the close connection that existed during the so-called industrial revolution (that may more accurately be described as industrial evolution) between introduction of new machinery and economic growth. Since new technology entered the economic sphere through investments (in machinery) it was the latter that was seen as the the constraining (or enabling) factor and that hence merited attention.

This tendency to reduce technology to machinery (or knowledge to artifacts) was something that not only affected economic orthodoxy. Even a highly heterodox economist such as Torstein Veblen argued along this lines when analysing catch-up processes in the world economy (Veblen 1915). In earlier times, Veblen argued, the diffusion of technology had been hampered by the fact that technology was mostly embodied in persons, so that migration of skilled workers was a necessary prerequisite for its spread across different locations. However, according to Veblen, the advent of “‘machine technology’ changed this logic completely (ibid. 191). In contrast to the conditions that had prevailed previously, he argued, this new type of knowledge “‘can be held and transmitted ... and the acquisition of it by such transfer is no laborious or uncertain matter” (ibid.). Hence, because of these changes, catch-up should be expected to be relatively easy and was under “‘otherwise suitable circumstances,” largely “‘a question of the pecuniary inducement and . . . opportunities offered ” (ibid. 192).

This optimistic mood with respect to what could be obtained through participating in technology diffusion came to be shared by most neoclassical economists in the early post-war period. According to Robert Solow, the most famous contributor to the development of the neoclassical theory of economic growth (Solow 1956), knowledge – or technology – should be regarded as a public good freely available to anybody with a desire to share it independent of their background or location. It follows that that it should be expected to benefit everybody to the same extent. This was also the assumption adopted in subsequent applied research based on this perspective. Edward Denison, the leading researcher of cross country differences in economic growth in the Western world in the early post war period, put it as follows: "Because knowledge is an international commodity, I should expect the contribution of advances of knowledge (...) to be of about the same size in all the countries..." (Denison 1967, p. 282). To the extent that differences in income and productivity across countries remained this should largely be explained by differential rates of capital accumulation in the past, related differences in saving behavior and demographic trends.

However, these optimistic predictions have not really been confirmed in reality (Fagerberg and Srholec 2005, Milanovic 2009). One important reason for the failure of these predictions, we shall argue, has to do with how technology and its contribution to economic development were conceived by those who made them. There is no such thing as a worldwide stock of homogenous knowledge that flows across the globe at the speed of light and which everybody can exploit as much as they like. Rather there are many different types of knowledge and knowledge holders. Not all knowledge is scientific, as the Nobel laureate Friedrich von Hayek pointed out long ago (Hayek 1945). Much knowledge is practical and context specific (which

does not make it less useful economically of course). Knowledge is also widely distributed across actors and contexts. As Hayek repeatedly stressed it is totally impossible for any actor, being a person or a firm (or a government for that sake), to know “everything” that may be relevant for the solution of an economic problem (what is often called “perfect knowledge”). In fact, just to identify what the relevant areas of knowledge are (and how these can usefully be approached) may be quite challenging.

Even in the case when the relevant knowledge can be identified, is codified and easily accessible, there is no guarantee that the knowledge will be successfully transferred. The knowledge may for example be difficult to understand and absorb. Higher education – even a doctorate or a whole group of people with such qualifications – may be required. Hence, it not sufficient to have access to knowledge, you must also have the necessary capabilities to understand, absorb and exploit it. Building such capabilities may be demanding, costly and time-consuming. Moreover, firms cannot rely on only one type of knowledge. They need to be able to access, absorb, combine and use many different types related to, for example, finance, logistics, products, markets, production etc. Access to necessary resources, such as ICTs, means of transport and skilled labour, and knowledge about how to access, keep and exploit those, is also crucial. It is of little help, say, to be aware of some promising knowledge if you cannot get hold of the resources necessary to reap the potential benefits from its exploitation.

If economic development primarily is about knowledge, then it must also be about the abilities of social actors to engage in the process of accessing, absorbing and using knowledge (so that income and welfare increase). Under capitalist conditions the most important social actor in this respect is the firm. From this perspective the gradual enhancements of firm’s capabilities in accessing, absorbing and using knowledge must be regarded as a crucial factor in economic development. The Korean development scholar Linsu Kim suggested the term “technological capability” for this phenomenon. He defined it as “the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies, (...) to create new technologies and to develop new products and processes...” (Kim 1997, p. 4).<sup>2</sup>

Kim’s analyses were based on lessons from how Korean electronics firms, such as Samsung, gradually upgraded from a passive role of implementing imported technology, to a more active role of introducing incremental improvements, and eventually ventured into the forefront of innovation-based competition. He therefore distinguished between different layers of technological capability depending of the complexity of the challenge: production capability, investment capability and innovation capability. Production capability - the most basic requirement - is needed to operate productive facilities efficiently. Investment capability is required for the arguably more challenging task of establishing new productive ventures. Finally, innovation capability is seen as necessary for the development of new goods or services that better meet the requirements of the market. Kim expected the requirements to become more stringent, in particular with respect to innovation capabilities, as countries climb up the development ladder. Thus, following his view, for a firm or country in the process of catching up, the appropriate level of technological capability is a moving target.

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<sup>2</sup> To the best of our knowledge the first to use this concept in print was Kim in an article in *Research Policy* (Kim 1980). It quickly became widely used, see for example Fransman and King(1984) and Lall (1987). For a survey and an application to the national level see Lall (1992).

Having pointed out the important role that firm level technological capabilities play in the process of development we now turn to question of how the development of such capabilities depends on the firm's environment. Firms are not isolated islands and their performances are also influenced by the characteristics of the environment in which they operate, such as, for example, customers, suppliers and other firms and organisations with which firms are in regular contact (Lundvall 1992). That the social, institutional and political characteristics of the environment in which a firm operates influence its performance, is not a new insight. Already in the 1960s Irma Adelman and Cynthia Morris pointed out, on the basis of an in-depth study of a number of indicators on development for a large number of countries, that "the purely economic performance of a community is strongly conditioned by the social and political setting in which economic activity takes place" (Adelman Morris 1965, p. 578). This point was also emphasized by the economic historian Moses Abramowitz, who used the term "social capability" for this aspect (Abramowitz 1986). He defined it as "countries' levels of general education and technical competence, the commercial, industrial and financial institutions that bear on the abilities to finance and operate modern, large-scale business, and the political and social characteristics that influence the risks, the incentives and the personal rewards of economic activity" (Abramowitz 1994a, p. 25). These are some of the aspects that he emphasized as important aspects of social capability (Abramowitz 1986, 1994a, b):

- technical competence (level of education)
- experience in the organization and management of large scale enterprises
- financial institutions and markets capable of mobilizing capital on a large scale
- the stability of government and its effectiveness in defining (enforcing) rules and supporting economic growth
- the spread of honesty and trust across the population.

Hence in "social capability" Abramowitz included not only to aspects related to governance (and education) but also the character of prevailing cultural norms, such as, e.g., the spread of honesty and trust in the population, which he saw as important for the ability to exploit technological opportunities. This is also emphasized by Putnam (1993) and other writers on "social capital" and has led to a rapidly increasing body research on the role of social capital in economic development ( for an overview see Woolcock and Narayan 2000).

Many of the same concerns that led Adelman and Morris and Abramowitz to focus on the role of social aspects in development are also central in the more recent literature on "national innovation systems"(NIS). The NIS concept first appeared in work by Christopher Freeman (Freeman 1987), Bengt Åke Lundvall (Lundvall 1992) and Richard Nelson (Nelson 1993), and this analytic framework has since been extensively used in both scholarly and policy-analytic work (Sharif 2006). The concept may be used in a narrow as well as a broader sense (Edquist 2004). The narrower definition of the national innovation system includes innovative firms and the public research infrastructure with which they interact in varying degrees (Nelson 1993). The broader definition extends this to all learning and innovation activities in a country regardless of where these take place (Lundvall 1992, Edquist 2004). The latter (broader) definition arguably comes closer to Adelman's and Abramowitz' approaches than the former.

The discussion so far leads to two propositions: 1) that generation of (firm-level) technological capabilities is a must for countries that wish to catch up and 2) that the degree of success in this aim to a large extent depends on wider economic, social, institutional and political factors. While many would sympathize with these propositions, they might perhaps have doubts about the possibility to explore these through empirical research. In fact Abramovitz himself was quite pessimistic in this regard. However, the availability of relevant empirical indicators has improved a lot in recent years, not the least for “non-economic” aspects of development. Based on recent research the next section discusses how technological and social capabilities can be measured.

### 3. Can Capabilities be Measured?

Drawing on recent work on the subject (Fagerberg and Srholec 2008) we now turn to the question of how capabilities can be measured empirically. Basically the approach is to assemble a set of indicators considered relevant for the phenomenon we wish to capture and construct a composite variable with the help of factor analysis.<sup>3</sup> The underlying assumption is that indicators reflecting the same dimension of reality should be expected to be strongly correlated. Factor analysis is a helpful technique in this respect also because it checks whether this is indeed the case. A challenge in this type of research is to strike the right balance between broad, high quality information on the one hand and wide country coverage and long time series on the other hand. In general, there is much more information available for already developed countries than for the poorer part of the world. Hence, being very ambitious with respect to what types of data to include could easily lead to the exclusion of most developing countries. In this paper we want to analyze the relationship between capability formation and economic performance (i.e., include the time series dimension to some extent) and include a fair number of developing countries into the analysis. This choice puts limitations on the data sources and indicators that we are able to use. The resulting sample consists of 100 countries on different levels of development over the period 1995-2011.<sup>4</sup>

Figure 1 illustrates the relationship between the theoretical concepts used in this study and data sources that may be relevant when it comes to putting numbers on these concepts. As pointed out above, Kim distinguished between three layers of technological capability: innovation capability; production capability and finance capability. For the former relevant indicators may range from the quality of a country’s research system (measured by its scientific production for example), the provision of advanced skills (such as scientists and engineers), R&D expenditures and patents. For the sample considered here only two of these were available, however, namely patents and scientific production. With respect to production capability, adherence to quality standards (ISO) may be a good indicator. Another indicator arguably reflecting “close to the market” innovative activities, e.g., competences of a type that would normally get unrecognized by, say, patents or R&D statistics, is the number of registered trademarks. Arguably, access to state of the art ICT is also very important for firms’ abilities to exploit knowledge commercially,

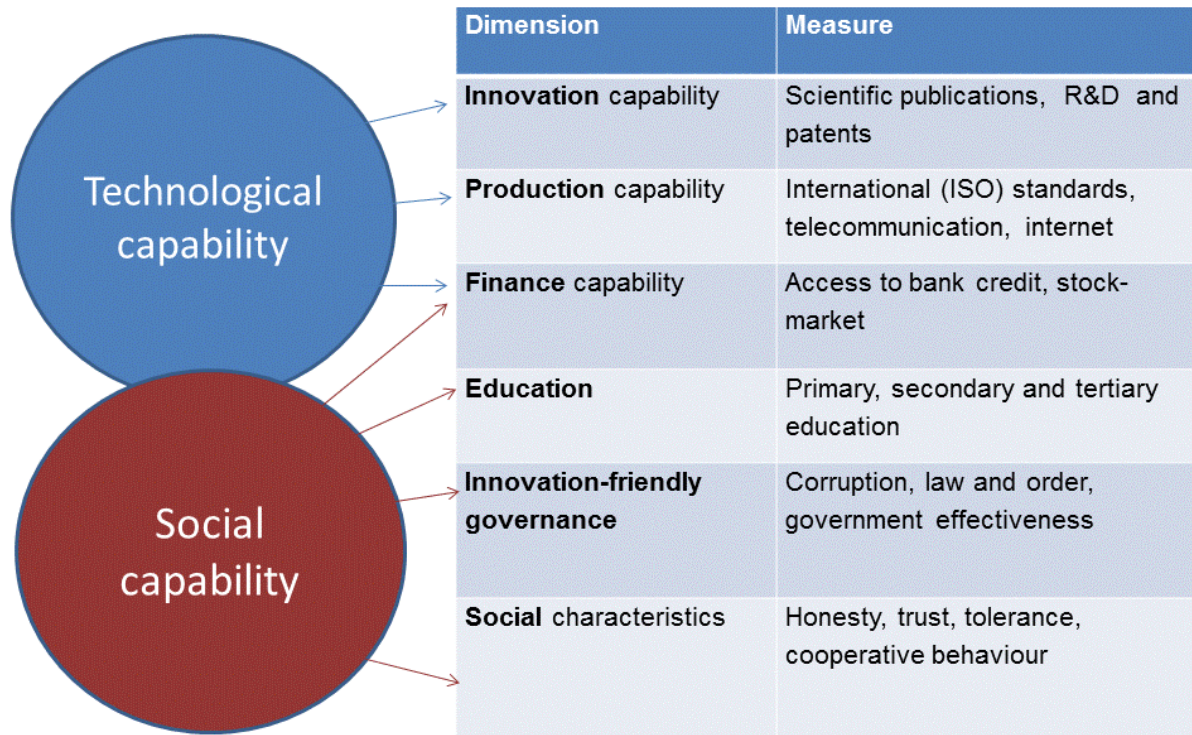
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<sup>3</sup> See Adelman and Morris (1965), Temple (1998) and Temple and Johnson (1998) for earlier applications of this methodology to cross-sections of countries.

<sup>4</sup> In a few cases a small share of the observations had to be estimated. Regarding technological capability the percentage of estimated data were 0.40% for articles and 7.80% for trademarks.

and an indicator covering this dimension ( the share of internet-users in the population) was therefore also included.

**Figure 1: How can Technological and Social Capability be measured?**



The lower half of Figure 1 indicates how the various aspects of “social capability” that, according to Abramovitz, are necessary for the successful economic development, can be measured. However, as follows from the discussion in the previous section, there is an overlap between the concepts technological and social capability in that they both include aspects related finance, although in different ways. This might not have created problems if we had been able to measure with precision what Kim and Abramovitz had in mind with respects to capabilities in finance. But the available indicators (see Table 2 and Figure 3 below) are limited to the development and performance of the country’s financial markets, and may arguably be closer to Abramovitz’s treatment of the subject than that of Kim. A second dimension of social capability emphasized by Abramovitz refers to the development of the country’s education system, for instance as reflected in the share of population with education at different levels. Yet another dimension, focusing on how “innovation” or “business friendly” the governance of a country is, may be accounted for by indicators reflecting how easy it is to set up (or close) a business, protection of IPRs, if laws and order are adhered to, to what extent corruption is a problem etc. In the present case (see Table 2) we have chosen to use the World Bank’s “government effectiveness” indicator<sup>5</sup> supplemented by separate indicators of law and orders

<sup>5</sup> Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy

and control of corruption from the same source.<sup>6</sup> Finally, Abramovitz' emphasis on "social characteristics" might be taken into account through the use of indicators reflecting the openness of society to people with different characteristics (origin, gender, sexual orientation etc.), the degree of trust among the citizens of a nation and the willingness to participate in civic activities of various sorts. A valuable source for exploring such cross-country differences in informal, culturally embedded norms and values would be "The World Value Survey". The coverage in that survey, however, is not wide enough to allow the inclusion of this dimension into the analysis here.<sup>7</sup>

Tables 1-2 present the results of the factor analyses for Technological and Social capability, respectively:

**Table 1: Technology capability: Results of the factors analysis**

	Factor loadings
USPTO patent grants (per mil. people)	0.93
Scientific and engineering articles (per mil. people)	0.86
Internet users (per 100 people)	0.82
ISO certificates (per mil. people)	0.94
Trademarks (per mil. people)	0.78
Number of observations	500

Note: The extraction method is principal-component factors; based on pooled data for 100 countries in 1995, 1999, 2003, 2007 and 2011, hence 500 observations in total. Only one eigenvalue higher than unity (3.77) explaining 75.5% of the total variance has been detected. All indicators used in logs; unity added to all variable/country/year cells in order to avoid log of zero.

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formulation and implementation, and the credibility of the government's commitment to such policies.

See <http://info.worldbank.org/governance/wgi/pdf/ge.pdf>

<sup>6</sup> See <http://info.worldbank.org/governance/wgi/resources.htm> for further details.

<sup>7</sup> See Fagerberg and Srholec 2009 for an attempt to analyse these issues with the help of the World Value Survey for a smaller number of countries and a more limited time-span.

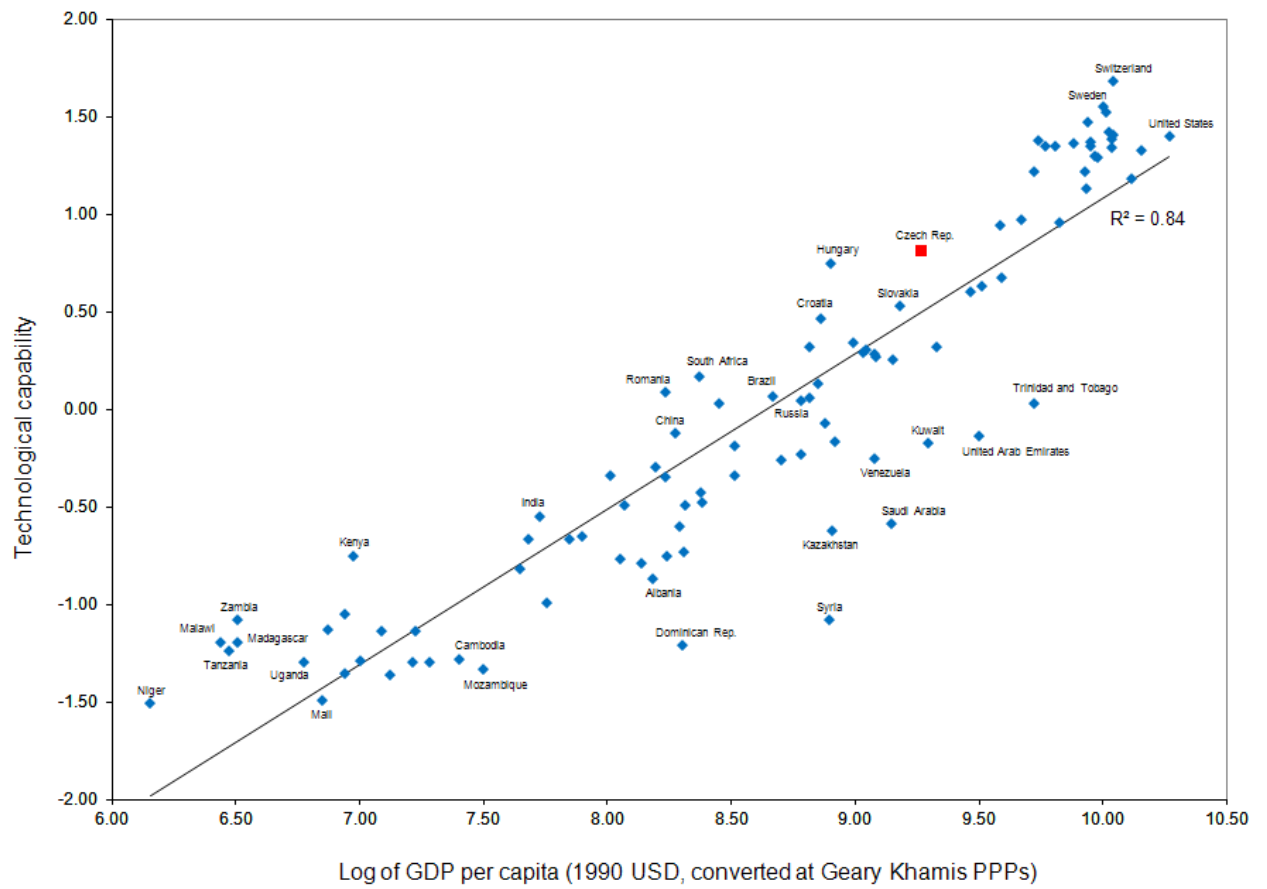
**Table 2: Capacity competitiveness: Results of the factors analysis**

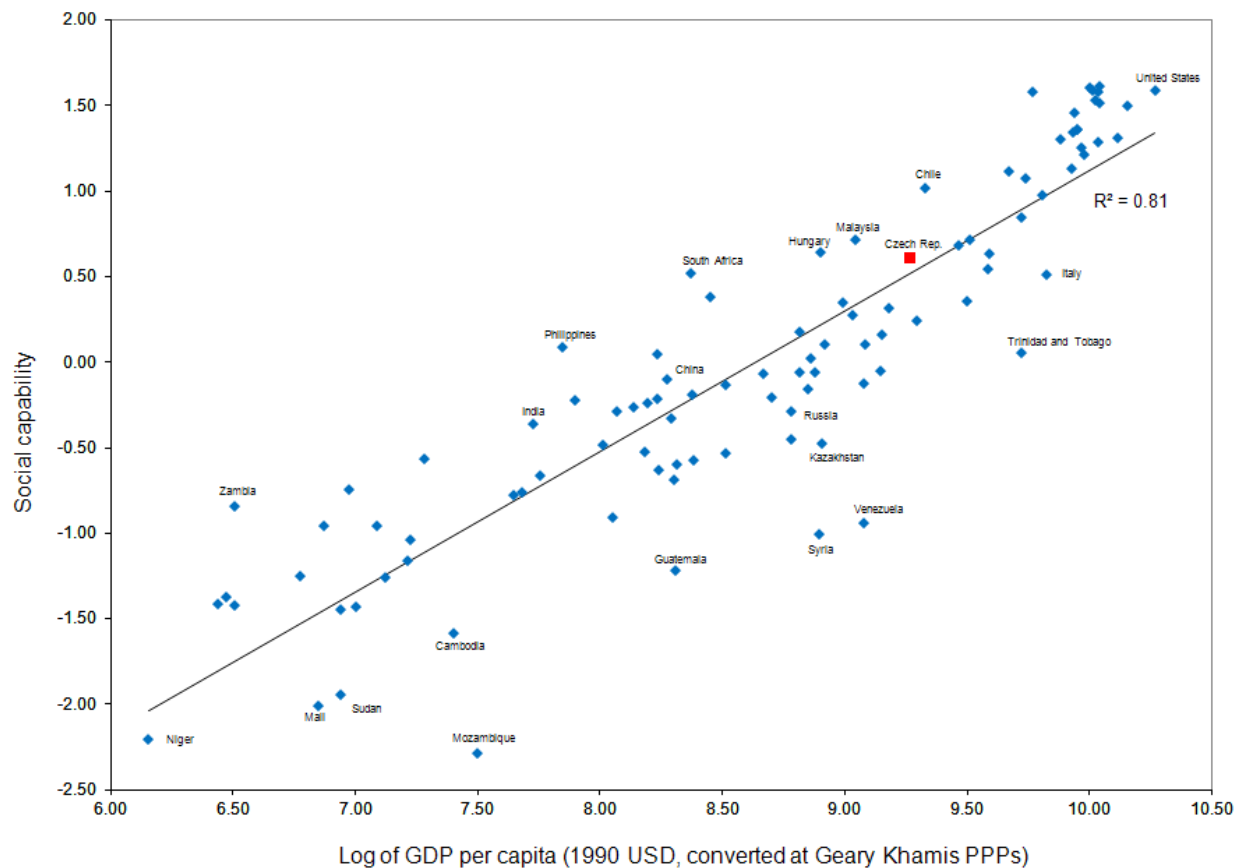
	Factor loadings
Average years of primary schooling (people aged 25 to 64)	0.68
Average years of secondary schooling (people aged 25 to 64)	0.76
Average years of tertiary schooling (people aged 25 to 64)	0.80
Domestic credit provided by banking sector (% of GDP)	0.83
Market capitalization of listed companies (% of GDP)	0.77
Government Effectiveness (index)	0.92
Rule of Law (index)	0.89
Control of Corruption (index)	0.87
Number of observations	500

Note: The extraction method is principal-component factors; based on pooled data for 100 countries in 1995, 1999, 2003, 2007 and 2011, hence 500 observations in total. The first eigenvalue (5.38) explains 67.3% of the total variance. All indicators used in logs; unity added to the variable of market capitalization to avoid log of zero.

As the results show, in both cases the indicators included in the analysis are very closely correlated with the respective factors. To explore the relationship between the composite measures of technological and social capability and economic development, Figures 2 and 3 plot the capability measures that emerge from the factor analysis against GDP per capita.

**Figure 2: Technological capability and GDP per capita (av. 1995-2011)**



**Figure 3: Social capability and GDP per capita (av. 1995-2011)**

What immediately strikes the eye are the very close correlations between the measures of technological and social capability and the level of economic development as reflected in GDP per capita. Thus capability building and economic development tend to go hand in hand. Although suggestive such correlations say little about what causes what, however. Moreover, although capability building may be important, there may be other factors at work as well. A more elaborate framework may therefore be needed.

#### 4. Capabilities, growth and competitiveness: A model

Having established the close relationship between technological and social capabilities of nations and their economic performance (as measured by GDP per capita), we will in this section go deeper into the processes behind these relationships. This will be done with the help of a formal model of economic growth, presented below, based on Schumpeterian logic<sup>8</sup>. In the model growth is assumed to be the outcome of innovation and diffusion of technology and capabilities necessary for their economic exploitation. As most growth models it abstracts from trade but to get a more complete understanding of the relationship with competitiveness we will in a second step account for that as well.

<sup>8</sup> The model presented in this section draws on earlier work (Fagerberg 1988a,b, Fagerberg, Srholec and Knell 2007).

Consider that the (volume of) GDP in a country ( $Y$ ) is a function of its technological knowledge ( $T$ ) and its capacity for exploiting the benefits of knowledge ( $C$ ):

$$(1) \quad Y = f(T, C),$$

where  $T$  is a function of knowledge (or innovation) created in the country ( $N$ ) and knowledge diffused to the region from outside ( $D$ ):

$$(2) \quad T = h(N, D).$$

Assume further that the diffusion of external knowledge follows a logistic curve (Metcalf, 1988). This implies that the contribution of diffusion of externally available knowledge to economic growth is an increasing function of the distance between the level of knowledge appropriated in the country and that of the country on the technological frontier. Hence, for the frontier country, this contribution will be zero by definition. Let the total amount of knowledge, adjusted for differences in size of countries (e.g., per capita, hence the *cap* superscript), in the frontier country and the country under consideration, be  $T_*^{cap}$  and  $T_i^{cap}$  respectively and let  $d$  be the rate of growth of knowledge diffused to the region from outside ( $D$ ):

$$(3) \quad d = \gamma - \gamma T^{gap}, \text{ where } T^{gap} = \frac{T_i^{cap}}{T_*^{cap}}$$

By differentiation and substitution we arrive at the following solution for growth of GDP, using small case letters for growth rates (e.g.,  $y = dY/Y$  etc.):

$$(4) \quad y = \gamma \varepsilon_{YT} \varepsilon_{TD} - \gamma \varepsilon_{YT} \varepsilon_{TD} T^{gap} + \varepsilon_{YT} \varepsilon_{TN} n + \varepsilon_{YC} c$$

where  $\varepsilon_{YT} = \frac{\partial Y}{\partial T} \frac{T}{Y}$  refers to the partial elasticity of GDP with respect to technology (similar for other variables).

In the model, three sets of factors determine the rate of growth of a country: (1) The potential for exploiting knowledge developed elsewhere; (2) the creation of new knowledge within the country; and (3) the growth in the capacity to exploit (or “absorb”) knowledge (independently of where it is created). The model encompasses many of the empirical models found in the literature on catching-up and differences in economic growth across countries. For instance, many if not most empirical models used in the “catching-up” literature are variants of equation (4) when we drop the innovation term (see, for example, Baumol *et al.*, 1989). Focusing more explicitly on the role of innovation for catch-up, Fagerberg (1987, 1988a) showed that countries that caught up very fast also had very rapid growth of innovative activity. The analysis suggested that superior growth in innovative activity was the prime factor behind the huge difference in performance between newly industrialized countries (NICs) in Asia and Latin America in the 1970s and early 1980s. Fagerberg and Verspagen (2002) have shown that the rapid increase in its innovative performance was the primary cause of the continuing rapid growth of the Asian NICs relative to other country groupings in the decade that followed. The research (Fagerberg, 1987; Fagerberg & Verspagen, 2002) also indicates that innovation may have become more important for economic growth over time (while imitation has become more demanding).

OECD has defined the international competitiveness of a country as follows:

”the degree to which, under open market competition, a country can produce goods and services that meet the test of foreign competition while simultaneously maintaining and expanding domestic real income” (OECD 1992, p. 237)

To analyse this phenomenon it is necessary to also include trade. To see how this may be done consider a two-economy model, in which one “country” interacts with the rest of the “world”. Let exports be  $X$ , imports be  $M$  and  $W$  be world demand, all measured in terms of volume. In addition to the two explanatory factors already taken into account, i.e., (1) The country’s technological competitiveness (its knowledge assets relative to competitors) and (2) Its capacity to exploit technology commercially (again relative to competitors), we now also include (3) Its price competitiveness (relative prices on tradeables in common currency); and (4) World demand. The two first factors, technology and capacity, are the same as earlier but measured relative to the world average. Consider exports as:

$$(5) \quad X = f(T, C, P, W),$$

where  $T$ ,  $C$ ,  $P$  is technology, capacity and price competitiveness in country  $i$ , relative to the

$$\text{world: } T = \frac{T_i}{T_{world}}, \quad C = \frac{C_i}{C_{world}}, \quad P = \frac{P_i}{P_{world}}$$

Since imports in this model are the “world’s ” exports, we can model imports in the same way, noting that the competitiveness variables in this case are the inverse of those in equation (5) and that domestic demand ( $Y$ ) replaces world demand:

$$(6) \quad M = g\left(\frac{1}{T}, \frac{1}{C}, \frac{1}{P}, Y\right)$$

If we - for the time being - take world demand and technology, capacity and price competitiveness as given, equations (5)-(6) give us two relationships between three endogenous variables ( $Y$ ,  $X$  and  $M$ ).<sup>9</sup>To solve the open economy model for, say, GDP growth we need an additional constraint linking growth to trade. It is common to assume in the literature that there exist economic mechanisms that prevent a country from continuing on paths that would not be sustainable in the long run, such as accumulating ever-increasing debts or claims on a grand scale vis-à-vis the rest of the world. This may occur through adjustments of the fiscal and monetary policy stance, but it may also be the result of working of markets, such as the capital, labour and currency markets. Fagerberg (1988b) and Meliciani (2001) tested this restriction on evidence from developed economies and found that it was supported by the data.<sup>10</sup> Formally, following earlier contributions by Thirlwall (1979) and Fagerberg (1988b), what we assume is balanced trade (equation (7) below) which is equivalent with balancing savings and investments. Note that an alternative way to formulate this restriction that would be consistent with the model is to assume that the surplus (deficit) used to service foreign debts (financed from foreign

<sup>9</sup> It is not possible to exclude a priori a feedback from the endogenous variables (growth and trade) on competitiveness but we have chosen to regard competitiveness as exogenous. See Fagerberg, Srholec and Knell (2007) for an extended discussion.

<sup>10</sup> Based on actual data for market shares for exports, prices and exchange-rates Fagerberg (1988b) calculated the growth rate of GDP (BAL) that would be consistent with (7) and tested whether this was equal to the actual growth rate.

assets) is a constant fraction of exports (or imports).<sup>11</sup> Thus, the analysis presented here is consistent with a world in which countries have foreign debts or assets.

$$(7) \quad XP = M$$

We assume, as before (equations (2)-(3)), that technology depends on both national sources ( $N$ ) and diffusion ( $D$ ) from abroad, and that the latter follows a logistic curve. By totally differentiating (2)-(3) and (5)-(7), substituting and rearranging, the following solution for growth of GDP follows:

(8)

$$y = \gamma \varepsilon_{TD} \frac{\varepsilon_{XT} + \varepsilon_{MT}}{\varepsilon_{MY}} - \gamma \varepsilon_{TD} \frac{\varepsilon_{XT} + \varepsilon_{MT}}{\varepsilon_{MY}} T^{gap} + \varepsilon_{TN} \frac{\varepsilon_{XT} + \varepsilon_{MT}}{\varepsilon_{MY}} n + \frac{\varepsilon_{XC} + \varepsilon_{MC}}{\varepsilon_{MY}} c + \frac{\varepsilon_{XP} + \varepsilon_{MP} + 1}{\varepsilon_{MY}} p + \frac{\varepsilon_{XW}}{\varepsilon_{MY}} w$$

We see that the growth of a country now depends on five factors: (1) The potential for exploiting knowledge developed elsewhere, which depends on the country's level of technological development relative to the world frontier; (2) Creation of new knowledge (technology) in the country relative to that of competitors; (3) Growth in the capacity to exploit knowledge, independently of where it is created, relative to that of competitors; (4) Change in relative prices in common currency and (5) Growth of world demand weighted by the ratio between the income elasticity for exports and that of imports.

By comparing equation (8) with the reduced form of the simple growth model considered previously (equation 4), we see that, apart from the two last terms on the right hand side, the model has the same structure. The only difference is that the coefficients of the growth equation (the reduced form) now are sums of coefficients for the similar variables in the equations for exports and imports divided by the income elasticity of imports. Hence, the higher the income elasticity for imports is, the lower the effect on growth of all other factors will be. Moreover, the two last terms in (8) resemble the open-economy growth model suggested by Thirlwall (1979). The first of these two terms is the familiar Marshall-Lerner condition, which states that the sum of the price elasticities for exports and imports (when measured in absolute value) has to be higher than one if deteriorating price competitiveness is going to harm the external balance (and – in this case – the rate of growth of GDP). The second reflects the argument put forward by Thirlwall (1979) and Kaldor (1981) that the extent to which a country is specialized in industries that are in high (low) demand at home and abroad may be of vital importance for its economic growth. Thus, the simple growth model outlined previously and the Kaldor-Thirlwall model may be seen as special cases of the more general Schumpeterian open economy model presented above.

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<sup>11</sup> As is easily verified, we may multiply the left or right hand side of (7) below with a scalar without any consequence for the subsequent deductions.

## 5. The competitiveness of nations: An empirical analysis

Fagerberg, Srholec and Knell (2007) fitted the above reduced form of the model (equation 8) to cross-sectional data for 90 countries on different levels of development between 1980 and 2002. In this paper we consider a larger number of countries and a more recent time period (1995-2011). We also depart from the earlier study by dividing the period in four and using panel estimation. This also allows us to consider the question of the extent to which the various factors taken into account here work in the same way during the present crisis (2007-2011) as in the preceding years. To measure the technology- and capacity-competitiveness variables in the model we use the measures for technological and social capability developed above. Variables reflecting price competitiveness (growth in relative unit labour costs in common currency) and world demand (growth in world demand weighted by the commodity composition of each country's exports) were also added. The latter was included as an approximation to the demand variable in the model.<sup>12</sup> Figure 4 shows how the variables were defined. The dependent variable is the growth of GDP over the period measured as the log difference of GDP (in millions of 1990 USD, converted at Geary Khamis PPPs).

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<sup>12</sup> Demand competitiveness is computed by weighting the growth, i.e. the log difference, of world demand by product ( $g_j$ ) weighted by the initial composition (specialization) of each country's exports ( $s_{ij}$ ):

$$w_i = \sum_{j=1}^m (g_j \times s_{ij}), \quad s_{ij} = \frac{X_{ij}^{t-1}}{\sum_{j=1}^m X_{ij}^{t-1}} \quad \text{and} \quad g_j = \ln\left(\sum_{i=1}^n X_{ij}^t\right) - \ln\left(\sum_{i=1}^n X_{ij}^{t-1}\right),$$

where  $X_{ij}$  denotes country's  $i$  ( $i = 1 \dots n$ ) exports of a product group  $j$  ( $j = 1 \dots m$ ) and  $t-1$  and  $t$  are two points in time. A high score indicates favourable demand conditions for country's exports. Both merchandise trade and trade in services is used in the calculation. Merchandise trade is used at 3-digit level of SITC, rev. 3 with 255 product categories, while the available data on trade in services allows us to distinguish only three service categories (transport, travel and other services).

Figure 4: The model: Concepts and variables

<b>Conclusion from the model:</b>	
<b>Growth = Catch-up potential + Competitiveness</b>	
<b>WHAT</b> to measure:	<b>HOW</b> to measure:
<b>Catch- up potential (the gap)</b>	$\ln(Y_{i,t}/Y_{us,t})$ ; GDP per capita, 1990 USD, converted at Geary Khamis PPPs
<b>Technological competitiveness</b>	Log difference of the factor score on technological capability
<b>Capacity competitiveness</b>	Log difference of the factor score on social capability
<b>Price competitiveness</b>	Log difference in real effective exchange rate
<b>Demand competitiveness</b>	Log difference of world demand weighted by export composition

Table 3 reports some main results from the analysis. To avoid simultaneity bias all explanatory variables but demand are lagged one period. This reduces the number of periods from four to three (maximum 300 observations). Four different estimation-methods are presented: Pooled OLS, Pooled robust OLS (robust to heteroscedasticity), Pooled OLS excluding major outliers,<sup>13</sup> and Random effects, which – for the same sample as the third column - checks for the possible impact on the estimates of non-included, unknown, time-invariant, country-specific factors (such as culture for example). As follows from the table, with the exception of price competitiveness (the estimate of which is not significant), all explanatory variables have the expected sign and are statistically significant at the 1% level. Table 4 repeats the Random effect estimation with variables reflecting differences in geography (including continent-dummies) and nature. The results indicate that the estimates are robust to the inclusion of such factors.

<sup>13</sup> The exclusion criterion is based on Cook's distance with a cut-off point of  $8 / \text{number of observations}$  threshold (which eliminates extreme outliers only). The excluded observations are one period for Ivory Coast, Iran, Nigeria, Tajikistan and Uruguay respectively and two periods for Venezuela.

**Table 3: Explaining GDP growth: Regression results ( 1999-2003, 2003-2007, 2007-2011)**

	<i>Pooled OLS</i>	<i>Pooled robust OLS</i>	<i>Pooled OLS outliers</i>	<i>Random Effects excl.</i>
Lagged gap	-0.41*** (0.04)	-0.42*** (0.04)	-0.43*** (0.04)	-0.46*** (0.06)
Lagged technology growth	0.20*** (0.05)	0.22*** (0.04)	0.25*** (0.04)	0.24*** (0.05)
Lagged capacity growth	0.15*** (0.05)	0.15*** (0.04)	0.14*** (0.05)	0.14*** (0.05)
Lagged price growth	-0.08 (0.06)	-0.06 (0.04)	-0.07 (0.05)	-0.06 (0.05)
Demand growth	0.43*** (0.04)	0.40*** (0.04)	0.42*** (0.04)	0.44*** (0.04)
F-test	48.06	47.40	52.17	..
Wald $\chi^2$	..	..	..	184.46
$\sigma_u$	..	..	..	0.39
$\sigma_e$	..	..	..	0.60
$\rho$	..	..	..	0.30
R <sup>2</sup> within	..	..	..	0.44
R <sup>2</sup> between	..	..	..	0.42
R <sup>2</sup> overall	0.41	0.37	0.44	0.44
Number of countries	100	100	100	100
Number of observations	296	296	289	289

Note: The dependent variable is the log difference of GDP (in millions of 1990 USD, converted at Geary Khamis PPPs). Absolute value of robust t-statistics in parentheses. \*, \*\*, \*\*\* denote significance at the 10, 5 and 1 per cent levels. Beta values of the parameters are reported.

**Table 4. Regression results with control variables**

	<i>Random effects</i>	<i>Random Effects</i>
Constant	0.29 (0.92)	-0.20 (0.13)
Lagged gap	-0.50*** (0.07)	-0.44*** (0.09)
Lagged technology growth	0.22*** (0.04)	0.21*** (0.05)
Lagged capacity growth	0.14*** (0.05)	0.13*** (0.05)
Lagged price growth	-0.05 (0.05)	-0.06 (0.05)
Demand growth	0.46*** (0.04)	0.44*** (0.04)
Lagged log of population	0.01 (0.06)	..
Lagged log of population density	0.08 (0.06)	..
Access to ocean	-0.07 (0.21)	..
Malaria ecology	-0.01 (0.01)	..
Lagged log of % of oil and gas in exports	-0.06 (0.04)	-0.12*** (0.03)
Europe transition dummy	..	0.19 (0.19)
Asia (excl. Japan) dummy	..	0.57*** (0.16)
Africa dummy	..	-0.03 (0.27)
Latin America dummy	..	0.09 (0.19)
Wald $\chi^2$	214.63	336.86
$\sigma_u$	0.38	0.33
$\sigma_e$	0.60	0.60
$\rho$	0.28	0.24
R <sup>2</sup> within	0.45	0.44
R <sup>2</sup> between	0.46	0.53
R <sup>2</sup> overall	0.46	0.50
Number of countries	100	100
Number of observations	289	289

Note: The dependent variable is the log difference of GDP (in millions of 1990 USD, converted at Geary Khamis PPPs). Absolute value of robust t-statistics in parentheses. \*, \*\*, \*\*\* denote significance at the 10, 5 and 1 per cent levels. Beta values of the core variables (those included in the theoretical model) parameters are reported.

To illustrate the implications of the above analysis for countries with different characteristics we divide the 100 countries into four broad groups (identified with the help of hierarchical cluster analysis, see Appendix A). The division is based on their level of development and technological and social dynamics.<sup>14</sup> Table 5 shows how the model (random effects estimates) explains the growth performance of groups of countries with similar characteristics with respect to level of development and technological and social dynamics.

**Table 5: Explaining GDP growth: A decomposition (1995-2011)**

	Actual difference in growth	Estimated difference in growth	Gap	Tech- nology	Capacity	Price	Demand	Random effect	Error term
Advanced	-5.3	-5.4	-4.9	0.2	-0.4	0.1	-0.4	0.0	0.0
Dynamic	4.1	2.9	-0.5	1.9	1.7	-0.3	0.1	0.7	0.5
Slow	0.9	0.9	1.3	-0.1	-0.5	0.0	0.2	0.1	0.0
LDCs	5.1	6.2	7.9	-2.1	0.1	0.0	0.3	-0.6	-0.5

As follows from the table differences in the scope for imitation (the GAP) are very important for explaining differences in growth between the least developed countries and the rest of the world. However, LDCs fail to exploit this potential to its full extent because of low capability growth and, to a lesser degree, a negative “random effect” (which reflects time-invariant, country specific factors). Still they grow much faster than many medium-income countries, belonging to a group termed “Slow”, reflecting their relatively modest capability growth. Hence, just as the LDCs they fail to exploit fully the potential for growth. This contrasts with the “Dynamic” group, consisting of Asian and Eastern European countries, which have very high capability growth and, consequently, also economic growth. These countries also have a positive “random effect” (though small compared to the capability part). Finally, the advanced countries – the developed part of the world – grow much slower than the average, largely because other, poorer countries thrive by exploiting technologies already in place in the advanced part of the world, a source of growth which by definition matters much less if at all for advanced economies.

Finally in table 6 we report an attempt to explore to what degree the positive effects of capability growth on development, reported above, are in any way affected by the economic crisis that set in after 2007 (i.e., the financial crisis and what followed). We do this by interacting the capability factors and the scope for imitation with a period dummy for the years 2007-2011. The results show that while improved “technological competitiveness” continued to matter, improved “capacity competitiveness” hardly had any effects at all during these years. However, demand mattered more than ever. A possible interpretation of these results is that the crisis was especially severe for countries that were not yet at the technological frontier, but that had made substantial investments in education and other factors related to exploitation of technology prior to the crisis.

<sup>14</sup> The three variables used to cluster the countries are the level of development, the growth of technological capability and the growth of social capability.

**Table 6. The impact of the crisis 2007-2011**

	<i>Random effects</i>	<i>Random effects</i>
Constant	0.15 (0.07)	0.07 (0.06)
Lagged gap	-0.44*** (0.05)	-0.39*** (0.07)
Lagged technology growth	0.16*** (0.04)	0.17*** (0.05)
Lagged capacity growth	0.13*** (0.05)	0.25*** (0.05)
Lagged price growth	-0.04 (0.05)	-0.03 (0.06)
Demand growth	0.35*** (0.04)	0.38*** (0.04)
Lagged gap * 2007-2011	..	-0.09 (0.10)
Lagged technology growth * 2007-2011	..	-0.02 (0.14)
Lagged capacity growth * 2007-2011	..	-0.28*** (0.10)
Lagged price growth * 2007-2011	..	-0.12 (0.11)
Demand growth * 2007-2011	..	0.37** (0.16)
2007-2011	-0.43*** (0.10)	..
Wald $\chi^2$	208.46	232.25
$\sigma_u$	0.40	0.36
$\sigma_e$	0.58	0.57
$\rho$	0.32	0.28
R <sup>2</sup> within	0.50	0.54
R <sup>2</sup> between	0.42	0.35
R <sup>2</sup> overall	0.46	0.46
Number of countries	100	100
Number of observations	289	289

Note: The dependent variable is the log difference of GDP (in millions of 1990 USD, converted at Geary Khamis PPPs). Absolute value of robust t-statistics in parentheses. \*, \*\*, \*\*\* denote significance at the 10, 5 and 1 per cent levels. Beta values of the core parameters (those included in the theoretical model) are reported.

## 6. Conclusions

This paper has argued that concepts such as capabilities and competitiveness are not only relevant for firms but also for nations. Countries are more than mere sums of the characteristics of the individuals that happen to live there. They are also repositories of knowledge, institutions and resources that underpin the economic activities within their respective borders. Such country-level characteristics influence the economic activities of its firms and citizens, just as these activities also contribute to shape the environment (e.g., the country) in which they take place.

Previous research has identified two main type of capabilities, technological and social. Technological capabilities refer to the ability to create and exploit knowledge to produce goods and services. Such capabilities are often firm-specific but depend in various ways on the environments in which firms operate as firms increasingly depend on external sources for developing and improving their capabilities. Technological capability also has an important national dimension as countries regularly devote large resources to develop and maintain such capabilities.

While technological capabilities have an important firms-specific component, social capabilities are characteristics of the social environment that firms share, and that influence firm's operations in various ways, from being a source of much needed resources, such as finance and skills, to for example providing an institutional and legal framework for their activities. Although politicians may influence the development of technological capability, and many examples – not the least from the emergence of the Asian Tigers as technological and economic powerhouses in the world economy – testify to that, their say is probably even larger when it comes to social capabilities.

The main argument put forward here when it comes to how to achieve economic growth is that both technological and social capabilities are essential. While technological capability provides a basis for competitiveness, social capability is a necessary prerequisite for its successful economic exploitation. The formal model presented here and its application to data for a large number of countries clearly confirms the crucial role played by technological and social capabilities for competitiveness.

The present economic downturn in the world economy, and in the Euro-area in particular, underscores the importance of national competitiveness for welfare. Failure in this respect may have very harmful effects indeed, as shown in the case of several South-European countries recently. Questions remain, however, about the long term effects of the crisis for the future performance of these and other countries, and this is an important issue for future research. The results reached in this paper indicate that many countries that invested in improving their social capabilities (and their capacity to exploit existing technology) in the years prior to the crisis, may have failed to reap substantial benefits of that investment in recent years. However, to the extent that the crisis leads such countries to cut back on future capability growth, this may well have a negative impact on their performance in the long run. An important policy objective, therefore, should be to avoid that the crisis affects technological and social capabilities negatively, because if this is allowed to happen, a return to a more satisfactory economic performance may be much more difficult to achieve.

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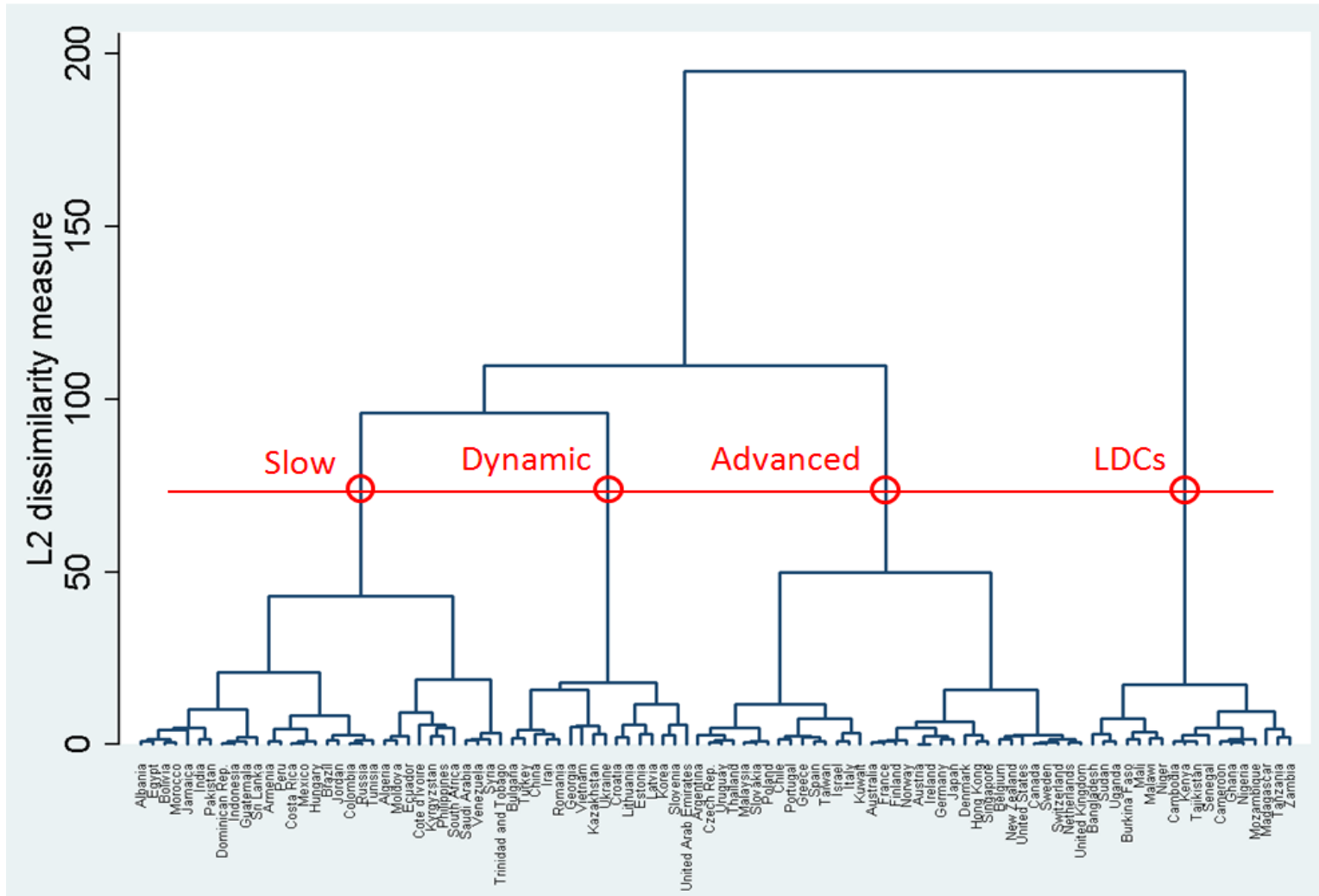
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Appendix A. Hierarchical cluster analysis



## Advanced

Argentina  
 Australia  
 Austria  
 Belgium  
 Canada  
 Chile  
 Czech Rep.  
 Denmark  
 Finland  
 France  
 Germany  
 Greece  
 Hong Kong  
 Ireland  
 Israel  
 Italy  
 Japan  
 Kuwait  
 Malaysia  
 Netherlands  
 New Zealand  
 Norway  
 Poland  
 Portugal  
 Singapore  
 Slovakia  
 Spain  
 Sweden  
 Switzerland  
 Taiwan  
 Thailand  
 United Kingdom  
 United States  
 Uruguay

## Dynamic

Bulgaria  
 China  
 Croatia  
 Estonia  
 Georgia  
 Iran  
 Kazakhstan  
 Korea  
 Latvia  
 Lithuania  
 Romania  
 Slovenia  
 Turkey  
 Ukraine  
 United Arab Emirates  
 Vietnam

## Slow

Albania  
 Algeria  
 Armenia  
 Bolivia  
 Brazil  
 Colombia  
 Costa Rica  
 Cote d'Ivoire  
 Dominican Rep.  
 Ecuador  
 Egypt  
 Guatemala  
 Hungary  
 India  
 Indonesia  
 Jamaica  
 Jordan  
 Kyrgyzstan  
 Mexico  
 Moldova  
 Morocco  
 Pakistan  
 Peru  
 Philippines  
 Russia  
 Saudi Arabia  
 South Africa  
 Sri Lanka  
 Syria  
 Trinidad and Tobago  
 Tunisia  
 Venezuela

## LDCs

Bangladesh  
 Burkina Faso  
 Cambodia  
 Cameroon  
 Ghana  
 Kenya  
 Madagascar  
 Malawi  
 Mali  
 Mozambique  
 Niger  
 Nigeria  
 Senegal  
 Sudan  
 Tajikistan  
 Tanzania  
 Uganda  
 Zambia